IMPERIAL MINERAL RESOURCES BUREAU.

THE MINERAL INDUSTRY OF THE BRITISH EMPIRE

AND

FOREIGN COUNTRIES.

WAR PERIOD.

ALUMINIUM AND BAUXITE.

(1913-1919.)

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PREFACE.

The following digest of statistical and technical information relative to the production and consumption of aluminium and bauxite will constitute a part of the Annual Volume on the Mineral Resources of the British Empire and Foreign Countries.

In this, the first year of publication, an effort has been made to fill in, as far as possible, the hiatus due to the war in the publications relating to mining and metallurgical statistics. Labour, health, and safety statistics have been omitted owing to the difficulty involved in procuring reliable information for the war period, but in future issues these statistics will be included in respect of each year. Resort will also be had to graphical representation of statistics of production, consumption, costs, and prices.

The weights are expressed in long tons, that is to say the British statute ton of 2,240 lb., and values in pounds, shillings, and pence at par rates of exchange.

R. A. S. REDMAYNE.
Chairman of the Governors.

2, Queen Anne's Gate Buildings,
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1921.

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GENERAL.

Aluminium is a white metal, having an atomic weight of 27·1. It is the lightest of the common metals, and has a specific gravity 2·58 in the pure cast condition. The metal is malleable between 100° and 150° C. It can be forged and rolled, drawn into tubes and fine wire, stamped, pressed, and beaten into thin leaves. Assuming an electrical conductivity of 100 for pure copper, aluminium has a conductivity of about 60.

Commercial aluminium usually contains from 98 to 99 per cent. of the metal, but ingots can be obtained containing only 0·3 to 0·5 per cent. of impurities. The most objectionable impurity is sodium, of which not more than traces should be present. Other impurities include silicon, which should not exceed 0·5 per cent., and iron, which should not exceed 0·3 per cent. in high-grade aluminium.

The chief aluminium minerals are corundum (alumina), bauxite, hydrargillite and diaspore (hydrated oxides), cryolite (a fluoride of aluminium and sodium), alum, alunogen, and alunite (sulphates), and numerous silicates including the felspars and clays.

Cryolite is found in commercial quantities only in South Greenland, where it is mined at Ivigtut, on the Araukfjord. This mineral was formerly the only ore of aluminium and it is still used as a flux in the extraction of the metal. It is also used in enamelling iron-ware and in the manufacture of Portland cement.

The Ivigtut deposits are owned by Kryolith Mine and Handelsselskabet, A/S, Copenhagen, Denmark, which holds a State concession for mining. The product is sold to the Pennsylvania Salt Manufacturing Company of Philadelphia, selling agents for America, and to Oresunds Chemiske Fabriker, Kommanditselskab ved C. F. Jarl, Copenhagen, selling agents for all other countries. Canada obtains its supplies through the American agents.

The annual shipments of cryolite from Greenland during the period 1913-1919 have been as follows :—

Year.	Quantity (long tons).
1913	10,248
1914	11,327
1915	9,408
1916	13,367
1917	9,482
1918	9,955
1919	6,265

Bauxite is the most important source of aluminium and its salts. It is a mixture of the hydrates of aluminium and iron with a certain amount of silica, silicates and titanium oxide. Its colour varies from grey to red, according to the percentage of iron. Its composition ranges generally between the following limits :—

	Per cent.		Per cent.
Alumina	30	to	60
Ferric oxide	3	,,	25
Silica	0·5	,,	20
Titanium dioxide	0	,,	10

Bauxite is employed (1) as raw material in the production of metallic aluminium, (2) in the manufacture of aluminium salts, (3) in the manufacture of refractory bricks, (4) in the manufacture of alundum (fused alumina) for use as an abrasive, and (5) in refining oil, a use of growing importance.

The greater part of the world's output is employed in the production of metallic aluminium. For this purpose the percentage of silica and titanium oxide should be as low as possible, but a certain amount of iron-oxide is not injurious except so far as its presence means a decrease in the alumina content. In the manufacture of chemicals such as alum, aluminium sulphate and other salts, comparatively pure bauxite is used, and it is desirable that the material should be as free as possible from oxide of iron. For some purposes practically pure hydrated alumina must first be obtained.

Large quantities of light alloys of aluminium, with copper alone, or with that and other metals, such as magnesium, have been used for war purposes, chiefly in the manufacture of aeroplanes and airships, but also in machine guns of the air-cooled type, in the manufacture of ammonal and other explosives, in soldiers' helmets and other parts of their equipment Other uses include wireless telegraph and telephone apparatus, barometer cases, and camera parts. The use of aluminium dust in place of zinc dust for precipitating gold and silver from cyanide solutions is increasing. Aluminium is also largely used in the " thermit " process of welding and casting, etc., aluminium in fine grains or filings being mixed with the oxide to be reduced. On being heated by a priming, such as magnesium powder, the aluminium combines violently with the oxygen, generating great heat, producing a fluid slag and setting free the metal, thus proving very useful in the welding of steel rails.

The Central Powers were seriously short of supplies of bauxite during the war, and the urgency of their need led to attempts to extract the metal from clays. In Norway it has been proposed to extract aluminium from the felspar labradorite.

World's Production of Bauxite

(long tons).

——	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	6,055	8,286	11,723	10,329	14,724	9,589	9,221
British Guiana ...	—	—	—	—	2,037	4,199	—
India	1,184	514	876	750	1,363	1,192	1,682
France	304,323		55,614	104,493	118,973		160,820
Hungary	—	—	58,118				
Italy	6,840	3,843	5,805	8,744	7,664	7,675	2,924
Spain	—	—	—	—	—	453	1,751
United States ...	210,241	219,318	297,041	425,100	568,690	605,721	376,566

Estimated World's Production of Aluminium

(long tons).

——	1913.	1914.	1915.	1916.	1917.	1918.	1919
United Kingdom ...	7,500	7,400	7,000	7,600	7,000	8,200	8,000
Canada	6,000	6,500	6,000	7,500	8,000	8,000	8,000
Austria	2,000	2,000	—	—	—	—	—
France*	13,283	9,803	5,920	9,447	10,886	11,826	12,000
Germany	1,000	1,000	1,000	8,000	20,000	25,000	12,000
Italy*	860	922	889	1,108	1,712	1,687	2,000
Norway	2,000	4,000	8,000	12,000	15,000	15,000	10,000
Switzerland	10,000	15,000	10,000	12,500	15,000	15,000	15,000
United States ...	29,000	41,500	44,500	62,500	80,000	85,000	80,000
Total	71,643	88,125	83,309	120,655	157,598	169,713	147,000

* Official figures. 1919 figure estimated.

BRITISH EMPIRE.

United Kingdom.*

All the bauxite produced in the United Kingdom comes from Ireland. It occurs associated with the pisolitic iron-ores and laterites of Antrim, in the area lying north and north-east of Lough Neagh, between Belfast Lough and the north coast of the county.

While many of the deposits seem to have originated from basalts, those of Glenarm and Straid Hill are associated with altered rhyolitic material. The nature of the Irish deposits has been discussed in the Memoir of the Geological Survey of Ireland on " The Interbasaltic Rocks (iron ores and bauxites) of North-east Ireland " (1912), where numerous analyses are quoted,

* For details relating to bauxite in Ireland, the Bureau is indebted to Professor Grenville A. J. Cole, Director of the Geological Survey of Ireland. Production statistics are taken from the Reports of the Chief Inspector of Mines, Home Office.

showing that the silica percentage is generally high. In several cases, however, and notably in the material from near Ballynure, the amount of silica present is comparatively low and not more than about 9 per cent. On account of its siliceous nature Irish bauxite has been used more for the manufacture of aluminium sulphate than for aluminium (*see* " Report of the Controller of the Department for the Development of Mineral Resources," page 23, 1918). The raising of bauxite as " alum-clay " began in 1873. The percentage of titanium dioxide varies at Glenarm from 2·56 to 9·40, and reaches 11·06 at Tuftarney.

The principal localities in County Antrim are :—

Clegnagh, west of Ballintoy. Pale grey and often pisolitic.

Essathohan, one mile north of Parkmore railway station.

Tuftarney, between Newtown Crommelin and Cargan.

Libbert Mine, Glenarm. Grey, and probably derived from rhyolite. Outcrop no longer exposed.

Irish Hill and Straid, E. of Ballynure and N.E. of Ballyclare. Probably derived from rhyolite. The bed in places overlies pisolitic iron-ore, both deposits being preserved under an outlier of Upper Basalt.

Bauxite has also been raised at the iron mines of *Cargan, Evishacrow*, and *Correen*, and at *Cullinane*, 2½ miles S.S.W. of Carnlough.

In the county of Londonderry, a brown-grey bauxite has been mined at *Killygreen*, four miles S.S.E. of Portrush.

A deposit of bauxitic clay was discovered recently in Ayrshire. Experiments made with this material show that it is likely to prove useful as a refractory. The material varies in chemical composition, showing from 26 to 50 per cent. of alumina, and 28 to 50 per cent. of silica, thus ranging in composition between a refractory clay and a bauxitic clay. Refined alumina is produced in the United Kingdom at Larne Harbour in Co. Antrim, Burntisland in Fifeshire, and Hebburn near Newcastle-on-Tyne. There are aluminium reduction works at Foyers in Inverness-shire, Kinlochleven in Argyllshire, and Dolgarrog in North Wales.

Production of Bauxite in the United Kingdom.

Year.	Quantity (long tons).	Value (£).
1913	6,055	1,563
1914	8,286	2,159
1915	11,723	3,163
1916	10,329	2,934
1917	14,724	4,132
1918	9,589	2,736
1919	9,221	2,811

*Prices of Aluminium in the United Kingdom.**

Year.	£ per ton Lowest.	Highest.
1913	81	85
1914	81	100
1915	100	160
1916	150	150
1917	225	225
1918	200	225
1919	150	200

Gold Coast.†

Deposits of high-grade bauxite have been discovered recently by the Gold Coast Geological Survey at and near the summit of Mt. Ejuanema on the Kwahu plateau, two miles to the west-south-west of Mpraeso, and about a mile to the south-south-west of Obomen. The summit of this hill is about 2,300 feet above sea-level, and about 1,000 feet above the Asuboni river. The rock formations consist of a series of irregularly alternating sandstones, sandy shales, and clay shales, disposed horizontally, though in some cases with slight inclinations to the north or north-east.

Bauxite is seen *in situ* along the whole of the rim of the top of the mountain and at the summit over a large area, also at various places below the broken rim for 100 feet below the summit.

Samples taken were passed through a 40-mesh sieve, the coarse and fine portions being analysed separately. The coarse portion constituted 95 per cent. of the whole and consisted of granular bauxite, while much of the fine material was of the same granular character. The average of seventeen analyses of the coarse portion was as follows :—

	Per cent.
Alumina	60·55
Ferric oxide	9·75
Titanium oxide	2·21
Silica	1·42
Lime and magnesia	0·73
Moisture	25·59

At the present time the nearest railway station is Tafo, 40 miles to the south. Coomassie railway station is 65 miles to the west. The railway from Tafo to Coomassie is now being extended, and will pass within a mile of the foot of Mt. Ejuanema

* The Bureau is indebted to Mr. Murray Morrison for this table of prices During the greater part of the war period, prices were fixed by the Ministry of Munitions.

† Annual Reports of Director of Gold Coast Geological Survey.

and within two miles of the deposit. An aerial ropeway will be necessary to connect the mine with the valley below.

The total amount of bauxite available at Mt. Ejuanema is estimated to be about 3,000,000 tons.

Canada.†

Bauxite is not mined in Canada, but the Dominion is nevertheless a very important producer of aluminium. This is owing to the water-power available at Shawinigan Falls, Quebec, where there is a large plant erected for the production of the metal. The method of treatment adopted is the Hall electric reduction process. The material treated consists of refined alumina imported from the United States. No unrefined bauxite is imported into Canada.

Imports of Refined Alumina and Aluminium into Canada.

Year.	Imports of Alumina.		Imports of Aluminium.						
			Ingots, Blooms, Bars.		Tubing.		Manufactures. (£)*.	Leaf or foil. (£)*	Total Value. (£)*
	Long tons.	(£)*	Long tons.	(£)*	Long tons.	(£)*			
1913... ...	13,707	128,065	1,543	125,955	9	1,911	27,487	—	155,353
1914... ...	12,749	119,046	1,695	155,386	7	1,437	21,488	928	179,239
1915... ...	15,632	185,965	1,188	131,355	3	625	17,350	1,136	150,466
1916... ...	24,026	232,096	603	109,076	2	642	19,877	10,217	139,812
1917... ...	77,816	388,800	312	65,956	2	644	28,674	21,493	116,767
1918... ...	83,224	431,471	125	21,865	3	929	39,097	18,106	79,997
1919... ...									

* Values converted to £ sterling at the rate of 1 dollar = 4*s*. 2*d*.

Exports of Aluminium from Canada.

Year.	Ingots, Bars, etc.		Manufactures.
	Long tons.	£*	£*
1913	5,810	367,128	1,709
1914	6,478	492,689	1,161
1915	8,340	694,526	129,284
1916	8,226	1,083,555	5,579
1917	9,966	1,587,699	3,576
1918	9,650	1,504,910	41,181
1919			

* Values converted to £ sterling at the rate of 1 dollar = 4*s*. 2*d*.

† Annual Reports on the Mineral Production of Canada. Annual Reports of the Trade of Canada.

Imports of Refined Alumina into Canada.

(Fiscal years ending March 31.)

From	Quantity (long tons).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	—	—	—	10	4	—	—
United States ...	11,715	13,389	11,197	16,432	35,680	73,710	84,924
Total	11,715	13,389	11,197	16,442	35,684	73,710	84,924
	Value (£).*						
United Kingdom ...	—	—	—	114	22	—	—
United States ...	109,379	125,095	104,543	205,733	275,143	365,775	478,484
Total	109,379	125,095	104,543	205,847	275,165	365,775	478,484

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Imports of Aluminium in Ingots, Blocks, Bars, Rods, Strips, Sheets or Plates into Canada.

(Fiscal years ending March 31.)

From	Quantity (long tons).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	414	588	432	168	12	9	53
Belgium	5	24	—	—	—	—	—
France	—	3	—	—	—	—	—
Germany	3	69	25	—	—	—	—
Norway	10	—	—	—	—	—	—
United States ...	611	1,160	1,014	947	363	321	76
Total ...	1,043	1,844	1,471	1,115	375	330	129
	Value* (£).						
United Kingdom ...	37,635	57,286	51,022	24,542	788	686	10,061
Belgium	443	2,503	—	—	—	—	—
France	—	317	—	—	—	—	—
Germany	312	7,812	2,584	—	—	—	—
Norway	828	—	—	—	—	—	—
United States ...	44,885	82,467	83,926	121,367	72,015	65,656	13,847
Total ...	84,103	150,385	137,532	145,909	72,803	66,342	23,908

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Imports of Aluminium Tubing in lengths of not less than 6 ft., not polished, bent, or otherwise manufactured, into Canada.

(*Fiscal years ending March* 31.)

From	Quantity (long tons).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	1	3	4	—	—	—	—
United States ...	3	5	2	2	3	2	4
Total ...	4	8	6	2	3	2	4
	Value* (£).						
United Kingdom ...	160	709	865	—	—	—	—
United States ...	573	991	508	562	852	762	1,162
Total ...	733	1,700	1,373	562	852	762	1,162

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Imports of Aluminium, Leaf and Foil, into Canada.

(*Fiscal years ending March* 31.)

From	Value* (£).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	—	—	275	100	19	—	5
Germany	—	—	538	—	—	—	—
United States ...	—	—	392	948	16,458	18,213	16,366
Japan	—	—	—	—	—	52	105
Total	—	—	1,205	1,048	16,477	18,265	16,476

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Imports of Aluminium Manufactures into Canada.
(Fiscal years ending March 31.)

From	Value* (£).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	1,925	3,257	663	383	341	33	85
Austria-Hungary ...	140	29	15	—	—	—	—
Belgium	16	14	10	—	—	—	—
France	1,031	1,117	877	471	597	955	801
Germany	2,946	3,939	863	—	—	—	—
Italy	15	—	39	—	—	—	—
Netherlands ...	—	—	2	—	—	—	—
Sweden	—	—	—	—	2	—	1
Switzerland ...	56	26	—	—	—	—	—
United States ...	19,499	23,131	15,705	15,362	22,966	26,744	41,282
Japan	—	—	—	—	5	1	66
Total	25,628	31,513	18,174	16,216	23,911	27,733	42,235

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Exports of Aluminium in Bars, Blocks, etc., from Canada (Domestic Produce).
(Fiscal years ending March 31.)

To	Quantity (long tons).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	1,874	1,929	2,310	5,645	6,507	9,528	3,420
British India	22	85	12	—	—	—	—
Australia	15	1	—	—	—	—	—
New Zealand	—	74	—	—	—	—	—
Belgium	1,049	1,044	231	—	—	—	—
France	—	—	—	—	—	—	1,892
Germany...	5	70	—	—	—	—	—
Italy	—	—	—	—	—	89	1,000
Russia	10	128	100	—	—	—	—
Sweden	—	5	—	—	—	—	—
Mexico	15	—	—	—	—	—	—
United States	3,510	2,499	3,275	3,019	2,157	13	2,743
Japan	206	7	342	105	4	1	—
Total	6,706	5,842	6,270	8,769	8,668	9,631	9,055
	Value* (£).						
United Kingdom ...	95,656	126,221	168,797	491,430	921,755	1,563,117	521,967
British India	1,017	5,877	840	—	—	—	—
Australia	805	50	—	—	—	—	—
New Zealand	—	4,306	—	—	—	—	—
Belgium	54,237	70,601	16,190	—	—	—	—
France	—	—	—	—	—	—	288,890
Germany...	267	4,716	—	—	—	—	—
Italy	—	—	—	—	—	12,658	154,437
Russia	537	8,980	8,134	—	—	—	—
Sweden	—	348	—	—	—	—	—
Mexico	814	—	—	—	—	—	—
United States	175,971	171,135	263,356	266,889	292,071	3,585	433,050
Japan	10,548	490	25,766	8,837	769	190	—
Total	339,852	392,724	483,083	767,156	1,214,595	1,579,550	1,398,344

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Exports of Aluminium Manufactures from Canada (Domestic Produce).

(Fiscal years ending March 31.)

To	Value* (£).						
	1913.	1914.	1915.	1916.	1917.	1918.	1919.
United Kingdom ...	—	4	93,360	14,858	—	2,421	1,248
British South Africa	—	—	—	36	74	—	—
Bermuda	—	—	—	4	—	—	—
India	—	—	—	974	235	—	—
Australia	—	—	—	36	—	—	—
New Zealand ...	—	—	—	174	313	15	—
Belgium	—	—	—	4,950	—	—	—
France	—	—	—	4,375	—	5,816	2,784
Italy	—	—	—	—	36	—	—
United States ...	2,993	1,285	954	10,715	5,025	1,417	28,836
Peru	—	—	—	—	—	—	6,654
Venezuela	—	86	—	—	—	—	—
Total	2,993	1,375	94,314	36,122	5,683	9,669	39,522

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

British Guiana.*

The bauxite deposits of British Guiana are very extensive and of good quality. They have been traced through the colony from the Venezuelan to the Dutch border, and deposits have been found in Dutch and French Guiana.

Some of the deposits are readily accessible; ships drawing 16 ft. can reach the workings sixty miles above Georgetown, and the great waterfalls of the colony will afford ample cheap power for the electric treatment of the raw material if that proves to be feasible.

Analyses published by the Science Department in 1917 show that many of the deposits are rich in alumina. Material from one shaft showed on analysis 67 per cent. alumina and from another 64 per cent.

In 1917, 800 men were employed and the output was 2,037 tons of ore, which was exported to the United States.

During 1918, 4,199 tons of ore was shipped. During 1919, stocks appear to have been accumulating, and there were no shipments in that year; but during 1920 the exports amounted

* Reports on the Lands and Mines Department (Annual).

to 29,399 tons, bringing the total quantity shipped since mining operations were begun up to 35,635 tons. Royalty was paid at the rate of 10 cents per ton.

Nine samples of bauxite from Akyma, on the Demerara River, showed the following average composition :—

	Per cent.
Alumina	59·56
Silica	2·65
Ferric oxide	2·49
Titanium dioxide	3·80
Combined water	30·39
Moisture	1·11
	100·00

The range in composition of the nine samples is shown by the maximum and minimum percentages of the different chemical constituents, which were as follows :—

	Maximum. Per cent.	Minimum. Per cent.
Alumina	61·08	57·30
Silica	4·58	1·07
Ferric oxide	3·35	1·30
Titanium dioxide	4·84	2·00
Combined water	31·62	27·86
Moisture	3·88	0·54

India.*

Some years ago it was discovered that many of the laterite deposits of India were highly aluminous, and consisted of bauxite. Systematic field work by the Geological Survey has proved the existence of extensive deposits of bauxite in many parts of India, and chemical investigations have shown that certain of the Indian bauxites compare favourably with some of the best bauxites of commerce.

The richest areas yet discovered in India are the Baihir plateau in the Balaghat district, and the vicinity of Katni in the Jubbulpore district, both in the Central Provinces. Bauxite of good quality has also been found on the laterite plateaux in the western parts of Chota Nagpur and in Sarguja, Bihar and Orissa; in Bhopal and Rewah States, Central India; in the Satara district, Bombay, and in various parts of the Madras Presidency. The deposits to which most attention has been paid up to the present time are those of Balaghat and Jubbulpore. Eight analyses of

* Records of the Geological Survey of India. Annual Statements of the Sea-borne Trade of British India.

specimens and samples of the Balaghat bauxites have given results ranging between the following limits :—

	Per cent.
Alumina	51·62 to 58·83*
Silica	0·05 ,, 2·65
Ferric oxide	2·70 ,, 10·58
Titanium dioxide	6·22 ,, 13·76
Combined water	22·76 ,, 30·72
Moisture	0·40 ,, 1·14

Two Katni bauxites gave the following results :—

	No. 1.	No. 2.
Alumina	65·48	52·67
Silica	0·38	1·26
Ferric oxide	3·77	7·04
Titanium dioxide	11·61	7·51
Water	19·38	29·83

These figures show that the Balaghat and Jubbulpore bauxites contain an appreciable percentage of titanium dioxide, but are otherwise of good quality, and there is no doubt that large quantities are available.

In western Chota Nagpur the rock laterite is believed to have been formed chiefly by hydration of basaltic lava flows.

Several concessions have been taken out for working bauxite, especially in the Central Provinces, and as a result of the attention recently paid to them, and of schemes for the local production of aluminium and alumina, the Geological Survey of India has decided to examine all the known bauxite deposits in the Indian Empire and to publish a memoir on the subject. It was anticipated that the greater part of the field-work would be completed by the end of the season 1919-1920.

Production of Bauxite in India.

Year.	Quantity (long tons).	Value (£).
1913	1,184	33
1914	514	32
1915	876	29
1916	750	463
1917	1,363	620
1918	1,192	894
1919	1,682	1,934

* Corresponding to from 71·2 to 80·8 per cent of alumina after calcination.

Imports of Aluminium into India.

(Fiscal years ending March 31.)

From	1913.	1914.	1915.	1916.	1917.	1918.	1919.
	Quantity (long tons).						
United Kingdom ...	339	392	268	418	7	2	—
East African Protectorate	—	—	—	—	2·5	—	—
Other British Possessions	—	—	—	—	·5	—	—
Straits Settlements	—	—	—	—	—	—	2
Total from British Empire	339	392	268	418	10	2	2
Austria-Hungary ...	1	1	3	—	—	—	—
Belgium	73	39	41	14	—	—	—
France	5	85	15	—	3	—	—
Germany	956	607	301	29	—	—	—
Holland	1	2	—	—	—	—	—
Italy	—	12	13	—	—	—	—
United States ...	415	179	135	301	24	31	135
Japan	—	—	1	10	4	3	383
Other Foreign Countries	—	—	—	—	—	—	—
Total from Foreign Countries.	1,451	925	509	354	31	34	518
TOTAL ...	1,790	1,317	777	772	41	36	520
	Value (£).						
United Kingdom ...	31,054	40,656	30,343	50,722	1,901	434	138
East African Protectorate	—	—	—	—	841	6	—
Other British Possessions	—	76	4	28	54	16	11
Straits Settlements	—	—	14	20	—	24	212
Total from British Empire	31,054	40,732	30,361	58,770	2,796	480	361
Austria-Hungary ...	111	77	334	—	—	—	—
Belgium	6,806	4,141	4,563	1,509	—	—	—
France	605	8,755	1,678	—	199	11	—
Germany	93,566	68,510	34,934	3,247	32	4	—
Holland	106	177	—	—	—	—	—
Italy	—	1,174	1,387	—	—	—	—
United States ...	37,849	18,937	13,659	38,037	7,649	13,028	42,465
Japan	—	—	130	1,770	1,584	1,505	106,387
Other Foreign Countries	—	25	—	—	30	—	—
Total from Foreign Countries	139,043	101,796	56,685	44,563	9,494	14,548	148,852
TOTAL ...	170,097	142,528	87,046	95,333	12,290	15,028	149,213

Australia.

In Queensland there are a number of occurrences of bauxite, including those at Cania about 60 miles south-west of Gladstone, Crow's Nest near Toowoomba, and Cooranga Station in the Gayndah district, but no systematic investigation has yet taken place.

Eighteen miles west of Springsure, near the Tambo road, there is a deposit of alunogen, a hydrated sulphate of alumina, covering the exposed faces of a low escarpment of sandstone, the rock itself being highly impregnated with the mineral wherever it has been tested.

In New South Wales there are numerous occurrences of bauxite, but few of them appear to be sufficiently high in alumina and low in iron to be of importance as a probable source of aluminium. At Bullahdelah in New South Wales deposits of alunite are worked as a source of potash alum.

In South Australia a bauxitic clay, which is considered of commercial value, has been found in the Yankabilla district.

In Western Australia deposits of bauxitic clay occur on the Darling Range and on the Eastern Goldfield.

FOREIGN COUNTRIES.

France.*

Deposits of bauxite occur in the departments of Hérault, Bouches-du-Rhône, Var, and Alpes Maritimes, forming a band that lies almost parallel with the shore of the Mediterranean. In Provence and Languedoc the bauxite deposits are worked in open quarries and sometimes in mines, but as a rule the workings do not extend more than about 160 feet from the surface. Three varieties of the mineral are found in France. The bauxite of Villeveyrac in Hérault is white; it contains a high percentage of alumina, very little iron and silica, and is used for the manufacture of aluminium salts. At Baux, near Arles, in Bouches-du-Rhône, the bauxite is red-banded; it contains about 60 per cent. of alumina and about 3 per cent. of silica, and is used for the manufacture of aluminium. At Thoronet and Luc, in Var, it is dark red, presents the appearance of a fine homogeneous paste, and breaks with a splintery conchoidal fracture.

Average analyses of Var bauxite are given as follows :—

	White variety.	Red variety.
	Per cent.	Per cent.
Alumina	58 to 64	50 to 65
Ferric oxide ...	4 ,, 8	12 ,, 25
Silica	7 ,, 10	1 ,, 3

A duty of 20 per cent. *ad valorem* is now levied on all exports of bauxite from France. This dates from October 22nd, 1920, before which there was no duty on exports of this mineral.

* Annuaire Statistique. Le Commerce de la France (Annual). Statistique de l'Industrie Minérale en France et en Algérie (1914–1918).

*French Production and Exports of Bauxite.**

Year.	Production.	Exports.	
	Quantity (long tons).	Quantity (long tons).	Value† (£).
1913	304,323	165,732	128,014
1914	—	147,761	114,120
1915	55,614	40,782	53,883
1916	104,493	61,793	100,480
1917	118,973	49,108	79,840
1918	—	37,002	60,160
1919	160,820	38,710	47,200

* The only imports of bauxite reported during the period under review were 860 tons in 1913, 2 tons in 1915, and 492 tons in 1919.

† Values converted to £ sterling at the rate of 25 francs = £1.

Imports and Exports of Aluminium (Ingots, Bars, Drawn, etc.) into and from France.

Year.	Imports. Quantity (long tons).	Exports. Quantity (long tons).
1913	93	4,441
1914	56	3,296
1915	98	2,899
1916	833	2,127
1917	1,480	1,210
1918	7,661	524
1919	4,765	3,573

Germany.

Before the war Germany imported a considerable amount of bauxite, mainly from France. This was refined, and a large quantity of the refined material was exported. Only a small amount of aluminium was produced in Germany. The demand for aluminium in the manufacture of zeppelins, aeroplanes, and the numerous other manufactures in which this metal was employed, compelled the Germans to look for new sources of the raw material, and supplies were obtained from Dalmatia and Hungary. At the same time the shortage of copper in Germany led to the extensive use of aluminium as a substitute. The consumption in 1904 was 2,000 tons, in 1913, 10,000 tons, and for the last year of the war it was estimated to be 32,000 tons. Many new factories were erected, and the output was very largely increased. The total production of aluminium in Germany at the beginning of 1916 is estimated at about 600 tons a month. In the spring of 1917 it had risen to about 2,000 tons a month: and by 1918 it is estimated to have reached 2,500 tons a month.

or about 30,000 tons a year. At the end of the war, output fell to about 1,000 tons a month. It was reported recently that new works erected would have a capacity of 10,000 tons, which would bring the total producing capacity of Germany up to 40,000 tons a year.

Italy.*

Some very valuable deposits of bauxite occur in Italy in the neighbourhood of Abruzzi and Tamnium. It has been reported that the Italian Government intended purchasing these deposits in connexion with the electrification of the railways, for which a large quantity of copper would be required unless aluminium were available. As Italy would be obliged to import copper, she is likely to substitute aluminium for it as far as possible. The increase in output is chiefly owing to larger production from Lesci dei Marsi. Of the 8,744 tons of bauxite produced in 1916, 7,419 were treated with caustic soda at the works of a company manufacturing aluminium at Bussi-sul-Tirino. This bauxite with a lesser quantity of natural and artificial cryolite and 12 tons of other alumina, yielded 1,108 tons of the metal, valued at £495,440.

Scarcely any aluminium, ingot or manufactured, is exported from Italy.

Production of Bauxite in Italy.

Year.	Quantity (long tons).	Value† (£).
1913	6,840	3,337
1914	3,843	1,875
1915	5,805	3,304
1916	8,744	4,960
1917	7,664	14,020
1918	7,675	14,640
1919	2,924	5,318

Production of Aluminium in Italy.

Year.	Quantity (long tons).	Value† (£).
1913	860	89,148
1914	922	101,196
1915	889	162,720
1916	1,108	495,440
1917	1,712	939,600
1918	1,687	350,540
1919	1,646	384,150

* Rivista del Servizio Minerario (Annual). Statistica di importazione e di esportazione (Annual).

† Values converted to £ sterling at the rate of 25 lire = £1.

Imports of Aluminium into Italy.

Year.	Ingot.		Wrought and Manufactured.	
	Quantity (long tons).	Value (£).*	Quantity (long tons).	Value (£).*
1913	100	8,976	375	54,885
1914	73	6,250	233	36,171
1915	1,595	136,147	43	7,159
1916	1,945	869,836	153	84,786
1917	3,738	2,051,298	194	134,655
1918	4,439	2,435,886	489	334,870
1919				

* Values converted to £ sterling at the rate of 25 lire = £1.

Jugo-Slavia.

Bauxite is found in Dalmatia on both sides of the lower part of the River Kerka, in the hilly part of the Zagorge, and on the central Dalmatian Islands. Other occurrences are those at Rammljane in the centre of Mosec plain, near Blaca and Konjsko north of Clissa, and at Kalun.

The Bureau is indebted to Dr. R. Seligman for the following analyses of Dalmatian bauxite :—

	I.	II.
Alumina	57·9	57·5
Silica	1·2	2·2
Ferric oxide	24·3	24·1
Lime	0·3	—
Titanium dioxide ...	4·2	3·8
Combined water ...	12·0	12·0
Moisture	0·4	0·6

According to a recent report (Mining Journal, 19th February, 1921) the total outputs of bauxite in Dalmatia and Istria for 1915, 1916, and 1917 were 59,946 tons, 140,038 tons, and 160,501 tons, respectively. The output in 1918 probably exceeded that of 1917.

Rumania.

The bauxite deposits of the Bihar Mountains in Rumania were discovered only a few years ago, and were not exploited until the war, at which time they were owned by Hungary. The development of the deposits was undertaken chiefly by the Bihar municipality to supply the demand of the German aluminium trade. The bauxite of this region is associated with limestones of Jurassic age, and forms extensive deposits.

At Fata Oarza there is an outcrop of bauxite, but transportation is as yet difficult, as there are no good roads.

The grey and red bauxites of the Bihar mountains show the following composition :—

	Grey variety. Per cent.	Red variety. Per cent.
Alumina	69	55·6
Silica	12	3·0
Ferric oxide	3	25·3
Water	15	11·0

Both varieties contain from 3 to 4 per cent. of titanium dioxide. They occur sometimes together and sometimes separately.

It has been estimated that the visible deposits in the Bihar district will yield from two to ten million tons of ore, while there is a possible reserve of another ten to twenty million tons. The deposits have been worked since 1915, and all the output has been exported to Germany.

In 1915 there was an output of 58,118 tons, valued at £29,509; and in 1916 the production is said to have been even greater.

The undertaking is in the hands of the Graf Kosniss Trust, to which the Jadtal Aluminium Mining Company and the Vaskoher Iron and Aluminium Mining Company also belong. The works of the first-named company are near Barátka, Elesd, Kalota, and Jadremete, and those of the latter near Rév and Bihardobrosd (Bihar district).

During the war the German factories were dependent upon these and the Dalmatian deposits for their raw material.

The ores yield from 25 to 30 per cent. aluminium.

Spain.*

Samples of bauxite found in various parts of Spain have not shown very satisfactory results when analysed, those obtained from Catalonia being highly siliceous. Prospecting for bauxite in the Spanish Pyrenees in territory corresponding to that wherein bauxite was found in France appears to have been unsuccessful. Official records show some production, but the source of the ore is not stated.

Switzerland.†

Bauxite is not found in Switzerland, but the manufacture of aluminium is a large and growing industry. The material treated formerly was calcined alumina and was imported from France, but during the war the greater part of the raw material was obtained from Austria-Hungary.

Prior to the war most of the unwrought aluminium exported from Switzerland went to Germany, and from 1915 onwards Germany took practically the whole of the exports.

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* Estadistica Minera de España (Annual).

† Statistique du Commerce de la Suisse (Annual).

Imports of Aluminium into Switzerland.

Year.	Quantity (long tons).	Value* (£)
1913	590	78,645
1914	406	59,771
1915	121	20,914
1916	189	38,673
1917	435	100,241
1918	371	79,022
1919		

Exports of Aluminium from Switzerland.

Year.	Quantity (long tons).	Value * (£).
1913	7,367	538,276
1914	7,351	595,139
1915	9,262	1,496,033
1916	11,192	1,978,460
1917	10,952	2,259,357
1918	11,187	2,534,613
1919	6,000	1,320,000

United States.†

The chief occurrences of bauxite in the United States are those of Arkansas, Georgia, Alabama, and Tennessee, about 80 per cent. of the output being obtained from Arkansas.

The ores are comparatively low in iron, and contain a high percentage of alumina. The chief areas worked in the Arkansas field are situated in Pulaski and Saline counties. In the former county the deposits occur immediately to the south of Little Rock, and in the latter they are found in the neighbourhood of Bryant, about twenty miles to the south of Little Rock. The Georgia deposits are found in the northern, central, and southern portions of the State. The northern deposits are usually high in alumina and low in silica, but in some parts the percentage of iron is high. The central Georgia deposits are found at a point about 15 to 20 miles east of the "Fall Line," which separates the Piedmont plateau in Georgia from the coastal plain area, and occur associated with sands and clays and a little limestone. The deposits are almost always low in iron, but contain from 50 to 60 per cent. of alumina and from 3 to 20 per cent. of silica.

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* Values converted to £ sterling at the rate of 25 francs = £1.

† Mineral Resources of the United States (Annual). Annual Report on the Foreign Commerce and Navigation of the United States.

Cryolite is imported into the United States free of duty. The statistics with reference to cryolite and bauxite, from 1913 to 1919, as compiled from the records of the Bureau of Foreign and Domestic Commerce, are shown in the following tables :—

Cryolite Imported and Entered for Consumption in the United States.

Year.	Quantity (long tons).	Value* (£)
1913	2,559	10,949
1914	4,612	19,672
1915	3,940	17,240
1916	3,857	34,421
1917	4,383	45,521
1918	1,950	20,312
1919	2,130	22,283

Production of Bauxite in the United States.

Year.	Quantity (long tons).	Value* (£)
1913	210,241	207,854
1914	219,318	222,749
1915	297,041	315,590
1916	425,100	478,417
1917	568,690	649,804
1918	605,721	718,332
1919	376,566	458,697

Imports of Bauxite into the United States.

Year.	Quantity (long tons).	Value* (£)
1913	21,456	17,864
1914	24,844	20,104
1915	3,420	3,564
1916	30	18
1917	7,691	6,039
1918	3,653	3,081
1919	6,082	7,671

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

Exports of "Bauxite"† from the United States (Domestic Produce).

Year.	Quantity (long tons).	Value* (£)
1914	5,374‡	50,017
1915	16,082	149,414
1916	18,032	205,720
1917	21,791	275,818
1918	19,711	317,435
1919	17,701	285,853

Consumption of Bauxite in the United States.

Year.	Quantity (long tons).	Value* (£)
1913	231,697	225,717
1914	238,788	192,835
1915	284,379	169,741
1916	407,098	272,715
1917	554,590	380,025
1918	589,663	403,978
1919	364,947	180,515

Value of Aluminium produced in the United States.

Year.	Virgin metal (£).*	Remelted scrap§ (£).*
1913	1,968,750	458,225
1914	2,100,000	348,571
1915	3,391,667	1,208,771
1916	7,062,500	4,881,292
1917	9,558,750	3,481,625
1918	8,574,792	2,107,000
1919	8,032,917	

Aluminium Imported for Consumption in the United States.

Year.	Ingot and semi-wrought.‖		Manufactures.¶ Value* (£).
	Quantity (long tons).	Value* (£).	
1913	11,203	914,226	82,504
1914	8,010	698,736	150,135
1915	4,149	367,910	15,794
1916	2,990	365,191	6,865
1917	40	7,372	4,480
1918	755	111,188	4,350
1919	6,184	943,871	7,920

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*

† Mostly refined alumina. ‡ From 1st July, 1914.

§ Value based on average open market price, as quoted by the Engineering and Mining Journal.

‖ Includes ingot, plates, sheets and wire.

¶ Includes aluminium leaf, kitchen utensils, and all other manufactures of aluminium.

Aluminium and Manufactures of Aluminium exported from the United States (Domestic Produce).

Year.	Ingot and semi-wrought.†		Manufactures (£).*
	Quantity (long tons).	Value* (£).	
1913	not stated.		201,270
1914	"	"	322,190
1915	"	"	767,108
1916	"	"	3,211,903
1917	4,472	952,332	2,086,515
1918	10,775	1,807,691	393,765
1919	2,241	363,520	446,965

Value of Exports of Aluminium from the United States (Domestic Produce).*

(Fiscal years ending June 30.)

To	1914.	1915.	1916.	1917.	1918.
	£	£	£	£	£
United Kingdom ...	35,809	315,809	139,274	1,273,006	423,477
British South Africa...	271	160	166	2,701	1,994
Canada...	114,209	124,085	187,869	198,660	181,451
India	14,266	18,645	11,015	18,028	4,397
Oceania	5,010	7,363	12,818	18,118	32,774
Foreign Countries ...	60,001	210,146	824,744	2,718,650	1,689,223
Total	229,566	676,208	1,175,886	4,229,163	2,333,316

Dutch Guiana.

Deposits of bauxite have been found in the eastern part of Dutch Guiana on the Surinam River, and have been opened out on Para Creek, Rena Reu Creek and Marechals Branch, all tributary to the Surinam River, and also on the Cotica River. The area covered by these deposits is 62 miles long and 62 miles wide.

Hitherto, however, there appears to have been little or no production. The output for 1919 is reported to have been 1,500 lb. valued at $6.

* Values converted to £ sterling at the rate of 1 dollar = 4*s.* 2*d.*
† Includes ingots, metal and alloys, plates and sheets.

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